REMARKS

Reconsideration of the present application, as amended, is respectfully requested.

The February 12, 2003 Office Action and the Examiner's comments have been carefully considered. In response, claims are amended and remarks are set forth below in a sincere effort to place the present application in form for allowance. The amendments are supported by the application as originally filed. Therefore, no new matter is added.

Inasmuch as the present amendment raises no new issues for consideration and, in any event, places the present application in condition for allowance or in better condition for consideration on appeal, its entry under the provisions of 37 CFR 1.116 are respectfully requested.

CLAIMS

Claims 1 and 4-18 are pending in this application. Claims 1 and 4-18 are amended to place the claims in better form for allowance. Specifically, claims 4-10 and 12-18 are amended to include the word --laser-- such that the preamble of these claims more clearly corresponds with the associated independent claim. Claims 1 and 11 are amended to change the statement "intercepting means for intercepting reflected waves from the connector" to --intercepting means for intercepting waves reflected by the connector--. The amendment to claims 1 and 11 is made for editorial purposes only and does not raise new issues.

Therefore, entry of the amendments to claims 1 and 4-18 is proper at this stage of prosecution.

PRIOR ART REJECTIONS

In the Office Action, claims 1, 4, 11 and 12 are rejected under 35 USC 102(e) as being anticipated by USP 5,910,962 (Pan et al.). Claims 5-10 and 13-18 are rejected under 35 USC 103 as being unpatentable over Pan et al.

According to the present claimed invention as defined by claim 1, the external cavity laser includes a FBG (fiber Bragg grating) section (20) provided on an optical path between a laser light emitting device (10) and a first connector (30), and intercepting means (27) provided on the optical path between the FBG section and the first connector (30) which intercepts waves reflected by the reflector. This arrangement prevents light which is provided by the laser light emitting device from being returned from the connector through the FBG section toward the external cavity formed between a reflection surface of the laser light emitting device and the FBG section, thereby reducing the relative intensity of noise (RIN).

It is respectfully submitted that claim 1 is patentable over Pan et al. for reasons, *inter alia*, set forth below.

Applicants respectfully state that the Examiner's contention in the last Office Action that WDM coupler 38 shown in Fig. 3B of Pan et al. corresponds to the connector of the present claimed invention is incorrect since the term "coupler" indicates a

device which is quite different from that indicated by the term "connector" in the field to which the present invention pertains.

For example, the following definitions are found in "FIBER OPTICS STANDARD DICTIONARY."

> **fiber optic connector**-A device that simply and easily permits coupling, decoupling, and recoupling of optical signals or power from each optical fiber in a cable to corresponding fibers in another cable.
>
> **fiber optic coupler**-A device that transfers optical signals from one propagation medium to another, usually without using a fiber optic splice or connector.

Pan et al. merely relates to a fiber laser that is entirely different from the external cavity laser recited in claim 1.

In the external cavity laser of the present claimed invention, a cavity is formed between a reflective surface of a semiconductor laser (LD) and an FBG disposed outside the semiconductor laser, as apparent from claim 1 wherein "a cavity that is formed <u>between the laser light emitting device and the grating, and that resonates the light between the reflective surface of the laser light emitting device and the grating</u>, thereby oscillating a laser beam having a given oscillation wavelength."

In contrast, in the fiber laser disclosed in Pan et al., a semiconductor laser is merely used for excitation, and a laser cavity is formed by reflection between two gratings both of which are disposed outside the semiconductor laser, as clearly stated at col. 2, lines 32-33 of Pan et al. In other words, a reflective surface of the semiconductor laser does not serve as a reflective

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surface of a "laser cavity including a grating" as recited in claim 1.

More specifically, lasers 14, 30A, 30B, 21A, 21B and the like are each constituted by a pumping laser whose emission wavelength (980 nm, 1480 nm, etc.) is different from an output light wavelength (1550 nm band) of a fiber laser (see col. 1, lines 32-35 of Pan '962 patent). In a fiber laser, pump light from a pumping laser 14, ..., 21B, or the like is supplied to a fiber doped with erbium, etc., thereby population inversion is caused in the fiber. By reciprocal light reflection between two gratings that are formed at a distance in the fiber, laser oscillation is caused at a wavelength determined by energy level difference in the erbium ion.

As explained above, the arrangement disclosed in Pan et al. patent differs entirely from the cavity laser recited in claim 1 which has a cavity formed by a reflective surface of a semiconductor laser and a grating. Thus, the Examiner's contention that Pan et al. disclose a laser having a cavity formed between a reflective surface of a laser and a grating as stated at page 3, lines 3-6 of the February 12, 2003 Office Action is incorrect. Hence, the Examiner's view that the disclosure of Pan et al. constitutes a bar to the patentability of this invention is respectfully believed to be improper.

APPLICANT'S REPLY TO EXAMINER'S RESPONSE TO ARGUMENTS

In the February 12, 2003 Office Action, the Examiner responds to applicant's argument that the term "coupler" indicates a device which is different from that indicated by the term "connector" by stating that although the terms are different, Pan et al. teaches that the coupler performs the same function as applicant's connector. With regard to applicant's statement that Pan et al. fails to disclose a cavity that is formed between the laser light-emitting device and the grating, and that resonates the light between the reflective surface of the laser light-emitting device and the grating, the Examiner states that Pan et al. do teach "a cavity 11 that is formed between the laser light-emitting device 14 and the grating 13." In support of his contention the Examiner points to Fig. 1A of Pan et al. and concludes, based on Fig. 1A of Pan et al. that it is inherent that the light resonates between the reflective surface of the laser light emitting device and the grating.

In response to the Examiner's comments set forth in the February 12, 2003 Office Action, applicant respectfully states that it is clearly described at col. 2, lines 29-34 of Pan et al. that

> "Fig. 1A shows a typical arrangement of a DBR <u>fiber laser</u> 10 with a pumping laser source 14. The DBR fiber laser 10 is formed by a section 11 of optical fiber which has at least a portion doped with the ions of a rare-earth metal, erbium. <u>A lasing cavity is defined by two fiber Bragg grating 12 and 13</u> at either end of the optical fiber section 11."

In contrast, applicant's invention is directed to an external cavity laser, not a fiber laser as taught in Pan et al. Applicant's invention has neither a portion of optional fiber doped with rare earth metal, erbium, nor a cavity defined by two fiber Bragg grating.

The cavity of applicant's external cavity laser does include a fiber Bragg grating at one end. At another end of the cavity, applicant's laser uses a reflective surface of a laser light emitting device, with a gain medium, or a semiconductor material of the laser light emitting device, interposed between the two ends, usually along a small length between two facets of the laser light emitting device.

The external cavity laser and the fiber laser operate on very different principles.

In the external cavity laser, a semiconductor material of the laser light emitting device is put into a population-inversion state through an injection of current, and a seed of light generated by a spontaneous emission inside the gain bandwidthh of the semiconductor material is amplified through stimulated emission while reciprocating between a reflective surface of the laser light emitting device and a fiber Bragg grating. Since a fiber Bragg grating creates a wavelength-dependent loss spectrum of the cavity, the laser oscillation occurs preferentially at a wavelength of the lowest loss. Therefore, the output light of the external cavity laser has a locked wavelength, but this wavelength falls within a gain

bandwidth of the semiconductor material of the laser light emitting device.

In the fiber laser, on the other hand, pumping light, which is supplied by a laser source (14) is fed to the cavity (11), where it excites erbium ions to higher energy levels. The excited ions are then relaxed to a lower energy level, but still higher than ground level. Thus a population inversion state is created. In such state, a seed of light, generated by a spontaneous emission is amplified through stimulated emission while reciprocating between the two fiber Bragg gratings 12 and 13. Since the fiber Bragg gratings create a wavelength dependent loss spectrum, the laser oscillation occurs preferentially at a wavelength of the lowest loss. Since the erbium ions experience a relaxation process which brings down the energy from a higher state to the lower state, the wavelength of the output laser light is different from, or naturally longer than that of the pumping light which was used to pump the erbium ions (see col. 1, lines 32-35 and col. 3, lines 9-18 of Pan et al.).

From the above-explained differences, it is readily apparent that the fiber laser and the external cavity laser are based on quite different principles, and that applicant's claimed invention is patentable over Pan et al.

With regard to the examiner's contention that "coupler" and "connector" are synonymous, applicant respectfully states the following.

Applicant has amended claims 1 and 11 such that the claims now recite that the intercepting means intercept the waves reflected by the connector in order to even more explicitly and clearly distinguish the connector of the present claimed invention from the coupler of Pan et al.

Applicant is still of the opinion that Pan et al. fail to disclose that the coupler reflects light. In Pan et al.'s fiber laser the isolator 35 is disposed in order to prevent light reflected at anywhere downstream thereof from being returned to the cavity defined by the two fiber Bragg gratings. In contrast, in applicant's external cavity laser, the isolator is disposed in order to prevent the light reflected at points downstream including specifically at the connector end face from being returned to the cavity defined by a reflective surface of the laser light emitting device and the fiber Bragg grating. Applicant notes for the Examiner that the coupler, such as a WDM coupler explicitly referred to in Pan et al., is usually fusion-spliced to fibers when it is used in fiber lasers or optical fiber amplifiers in an effort to minimize reflection and power-loss due to the reflection. As a result, there is no way of interpreting in Pan et al.'s apparatus that significant reflection occurs at the splicing point which is harmful to the laser operation. Therefore, although the examiner contends that the "coupler" in Pan et al. corresponds to the "connector" of the present claimed invention, Pan et al. fail to disclose that the

coupler may reflect light as is the case with the claimed connector. Therefore, the terms are not equivalent.

In view of the foregoing, claims 1 and 11 are patentable over Pan et al. under 35 USC 102 as well as 35 USC 103. Claims 4-10 and 12-18 are either directly or indirectly dependent on claims 1 and 11 and are patentable over Pan et al. in view of their dependence on either claim 1 or 11.

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In view of the foregoing, entry of this Amendment, allowance of the claims and the passing of this application to issue are respectfully solicited.

If the Examiner has any comments, questions, objections or recommendations, the Examiner is invited to telephone the undersigned at the telephone number given below for prompt action.

Respectfully submitted,

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COPY OF AMENDED CLAIMS SHOWING CHANGES BEING MADE
SERIAL NO.

Claims 1 and 4-18 have been amended as follows:

1. (Twice Amended) An external cavity laser for oscillating laser light through a connector, comprising:

a fiber Bragg grating section formed of an optical fiber having a Bragg wavelength of light reflected by a grating adjusted to a given wavelength;

a laser light emitting device that generates light, and that is optically coupled to the fiber Bragg grating section to ensure input and output of the light, said laser light emitting device including a reflective surface for reflecting the generated light;

a cavity that is formed between the laser light emitting device and the grating, and that resonates the light between the reflective surface of the laser light emitting device and the grating, thereby oscillating a laser beam having a given oscillation wavelength;

a connector that outputs the light oscillated by the cavity, said connector being a first connector provided on an optical path extending from the laser light emitting device; and

<u>an</u> intercepting means for intercepting [reflected waves from] <u>waves reflected by</u> the connector; <u>and</u>

wherein the fiber Bragg grating section is located on the optical path between the laser light emitting device and the connector; and

wherein the intercepting means is located on the optical path between the fiber Bragg grating section and the connector.

4. (Amended) The external cavity <u>laser</u> according to claim 1, wherein the intercepting means comprises an isolator.

5. (Amended) The external cavity <u>laser</u> according to claim 1, wherein the intercepting means comprises a circulator.

6. (Amended) The external cavity <u>laser</u> according to claim 1, wherein the connector comprises a physical connector.

7. (Amended) The external cavity <u>laser</u> according to claim 1, wherein the connector comprises a superphysical connector.

8. (Amended) The external cavity <u>laser</u> according to claim 1, wherein the connector comprises an angled physical connector.

9. (Amended) The external cavity <u>laser</u> according to claim 1, wherein a relative intensity of noise (RIN) less than -130 [dB] <u>dB/Hz</u> is maintained in a transmission band having frequencies equal to or less than 10 GHz.

10. (Amended) The external cavity laser according to claim 1, wherein a relative intensity of noise (RIN) less than -150 [dB] dB/Hz is maintained in a transmission band having frequencies equal to or less than 10 Ghz.

11. (Amended) An external cavity laser for oscillating laser light through a connector, comprising:

a fiber Bragg grating section formed of an optical fiber having a Bragg wavelength of light reflected by a grating adjusted to a given wavelength;

a laser light emitting device that generates light, and that is optically coupled to the fiber Bragg grating section to ensure input and output of the light, said laser light emitting device including a reflective surface for reflecting the generated light;

a cavity that is formed between the laser light emitting device and the grating, and that resonates the light between the reflective surface of the laser light emitting device and the grating, thereby oscillating a laser beam having a given oscillation wavelength;

a connector that outputs the light oscillated by the cavity, said connector being a first connector provided on an optical path extending from the laser light emitting device; and

an intercepting element for intercepting [reflected waves from] waves reflected by the connector;

wherein the fiber Bragg grating section is located on the optical path between the laser light emitting device and the connector; and

wherein the intercepting element is located on the optical path between the fiber Bragg grating section and the connector.

12. (Amended) The external cavity <u>laser</u> according to claim 11, wherein the intercepting element comprises an isolator.

13. (Amended) The external cavity <u>laser</u> according to claim 11, wherein the intercepting element comprises a circulator.

14. (Amended) The external cavity <u>laser</u> according to claim 11, wherein the connector comprises a physical connector.

15. (Amended) The external cavity <u>laser</u> according to claim 11, wherein the connector comprises a superphysical connector.

16. (Amended) The external cavity <u>laser</u> according to claim 11, wherein the connector comprises an angled physical connector.

17. (Amended) The external cavity <u>laser</u> according to claim 11, wherein a relative intensity of noise (RIN) less than

-130 [dB] dB/Hz is maintained in a transmission band having frequencies equal to or less than 10 GHz.

18. (Amended) The external cavity laser according to claim 11, wherein a relative intensity of noise (RIN) less than -150 [dB] dB/Hz is maintained in a transmission band having frequencies equal to or less than 10 Ghz.